# Syo KUROKAWA*: Studies on Japanese species of *Xanthoparmelia* (Parmeliaceae) (2)**

## 黒川 逍*: 日本産キクバゴケ属 (ウメノキゴケ科) の検討 (2)

**Xanthoparmelia hirosakiensis** (Gyeln.) Kurok., comb. nov. (Fig. 1)

*Parmelia hirosakiensis* Gyeln., Fedde Repert. **36**: 155. 1934—*Parmelia subconspersa* var. *hirosakiensis* (Gyeln.) Asah., Journ. Jap. Bot. **26**: 195. 1951. Type. Chateau Hirosaki, Aomori, Japan, Faurie 1077—holotype in BP (not seen) and isotype in KYO (2 packets).

*Parmelia subconspersa* var. *submonophylla* Asah., Lich. Japan **2**: 63. 1952. Type. Japan, Prov. Settsu, Mt. Rokko, Kobe, Y. Asahina 2001—holotype in TNS.

Thallus adnate to loosely adnate, yellow-green, saxicolous; lobes sublinear-elongate, continuous or imbricate, 1–2.5 mm wide; upper surface dull or a little shiny, sometimes faintly white-maculate, isidiate, simple isidia subglobose or cylindrical, 0.07–0.1 mm in diameter and 0.3 mm in height, branched isidia often coralloid, more or less constricted near the base of branchlets, 0.1–0.18 mm in diameter and 0.5–1.5 mm in height; medulla white; lower surface brown to pale blackish brown; rhizines sparse to moderate, mostly simple, of the same colour as the lower surface or blackish, rather coarse. Thallus 140–180 $\mu$m thick; upper cortex about 12 $\mu$m thick; algal layer subcontinuous, about 35 $\mu$m thick; medulla 80–110 $\mu$m thick; lower cortex pale brown, 12–24 $\mu$m thick. Apothecia rather rare, subsessile, 3–9 mm in diameter, disc more or less concave, chestnut brown, margin often undulate and crenate to deeply incised, amphithecium isidiate; hymenium about 45 $\mu$m high; spores colourless, simple, 5–6×10–11 $\mu$m.

Chemistry. Thallus K−; medulla K−, C−, KC−, P+ orange red; containing usnic acid, fumarprotocetraric acid (major) and protocetraric acid (minor).

This species has been considered to be conspecific with *X. subramigera* (Gyeln.) Hale (Yoshimura 1974), which was described from Hawaii. These

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** Continued from Journ. Jap. Bot. **64**: 165–175, 1989.

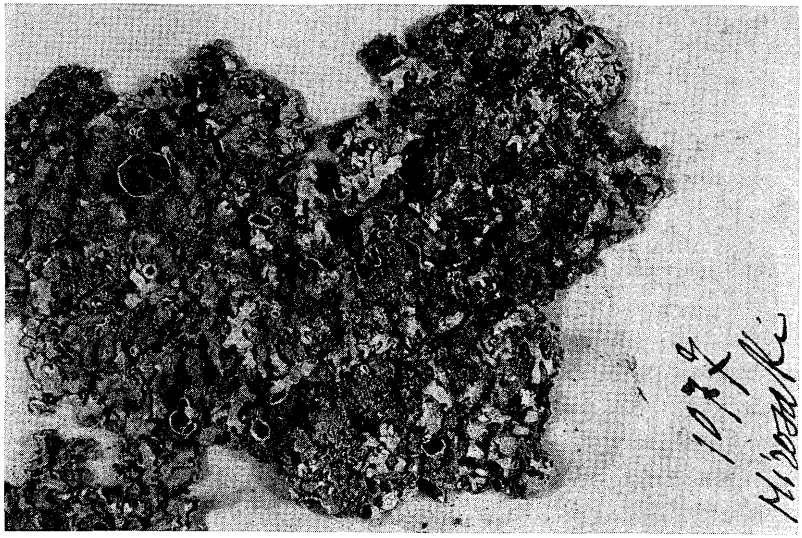

Fig. 1. An isotype of *Parmelia hirosakiensis* Gyeln. preserved at KYO (×1.2).

two species have similar adnate to loosely adnate thalli with isidia and show similar orange red colour reaction with P in the medulla. Lower surface of thalli, however, is much darker in *X. hirosakiensis* than in *X. subramigera*. In *X. hirosakiensis*, fumarprotocetraric (major) and protocetraric (minor) acids are demonstrated on chromatograms as secondary products in the medulla, whereas succinprotocetraric acid is the major component in the medulla and it always accompanies minor amount of fumarprotocetraric acid in *X. subramigera*, including an isotype (Rainbowfall, Insula Hawaii, alt. 50 m, Faurie 856) preserved in KYO. Even though these three substances are biosynthetically closely related, the replacement (Elix 1982) of major and minor substances seems to reflect the speciation of these two species in Japan and tropical America, including Hawaii, respectively. In addition, coralloid isidia of *X. hirosakiensis* are more or less constricted near the base of branchlets, while they are mostly cylindrical and are hardly constricted near the base of branchlets in *X. subramigera*. Isidia of the latter species are slenderer than those of *X. hirosakiensis* and are 0.07–0.12 mm in diameter even when coralloid-branched.

According to Asahina (1952), *Parmelia subconspersa* var. *submonophylla* has "thallus fere monophyllus, ambitu lobis rotundatis crenatisque, laciniis

secundariis rarescentibus". Continuous lobes, which are very rarely imbricate, seem to be one of ecological forms, and the variety is simply reduced as a synonym of *X. hirosakiensis*. On the other hand, Asahina (1952) cited a specimen (Faurie 995 collected at Aomori, Prov. Mutsu) as the "planta typica" of *Parmelia subconspersa*. This specimen is quite identical with the isotype of *P. hirosakiensis*.

Distribution. This species is known at present from Japan and north-eastern China (Manchuria). In Japan, it is distributed through Hokkaido to Kyushu, being one of the commonest species of *Xanthoparmelia* in Hokkaido and north-eastern Honshu (main island). In central Japan, it has been collected from low hills to higher elevations up to 2900 m above the sea level. Specimens examined[1] are 46.

Exsiccata examined. S. Kurokawa, Lich. Rar. Crit. Exs. no. 239 (sub *Parmelia subramigera* Gyeln.) (TNS).

**Xanthoparmelia tuberculiformis** Kurok., sp. nov. (Fig. 2)

Thallus ut in *Xanthoparmelia hirosakiensi*, sed superficie inferiore nigra et isidiis simplicibus et subglobosis vel ramosis et tuberculiformibus differt.

Thallus adnate to loosely adnate, yellow-green, saxicolous; lobes subirregular to sublinear, often imbricate, 1.0-2.5 mm wide, upper surface more or less shiny, usually emaculate, blackish brown or black margined near the lobe apices, isidia simple and subglobose or coralloid-branched, branchlets constricted near the base; medulla white; lower surface black; rhizines moderate, simple, black, rather coarse. Thallus 150-220 $\mu$m thick; upper cortex about 25 $\mu$m thick; algal layer continuous, about 50 $\mu$m thick; medulla 60-120 $\mu$m thick; lower cortex blackish brown in the outer half, about 17 $\mu$m thick. Apothecia rare, subsessile, 3-7 mm in diameter; disc concave, blackish brown, margin often incised, amphithecium isidiate; hymenium about 40 $\mu$m high; spores colourless, simple, 5×9-10 $\mu$m. Pycnidia immersed in the thallus. Pycnoconidia not seen.

Chemistry. Thallus K−; medulla K−, C−, KC−, P+ orange red; containing usnic acid, fumarprotocetraric acid (major) and protocetraric acid (minor).

Type. Japan, Hokkaido, Prov. Kitami, Otoineppu Cape, 6 km north-west of

1) All specimens cited in this paper are preserved at TNS, unless otherwise stated.

Fig. 2. Part of holotype of *Xanthoparmelia tuberculiformis* Kurok. (×1.1).

Ohmu, S. Kurokawa 70867—holotype in TNS.

This new species resembles *X. hirosakiensis*, because these two species have similar adnate to loosely adnate thalli with isidia and produce usnic acid, fumarprotocetraric acid (major) and protocetraric acid (minor). However, the lower surface of the thallus is black in *X. tuberculiformis*, whereas it is brown to blackish brown in *X. hirosakiensis*. Although juvenile isidia are subglobose in both species, branchlets of coralloid isidia are distinctly constricted near the base in *X. tuberculiformis* and they are only a little so in *X. hirosakiensis*.

Mainly because this species is isidiate and has black lower surface of lobes, it has been considered to be identical with *X. piedmontensis* (Hale) Hale (Yoshimura 1974), an eastern North American species showing similar orange red colour reaction with P in the medulla. However, these two species are clearly distinguished by the nature of isidia: *X. tuberculiformis* forms simple subglobose isidia (about 0.1 mm in diameter) and coralloid-branched isidia (about 0.15 mm in diameter) composed of branchlets constricted near the base, while *X. piedmontensis* produces cylindrical and simple or coralloid-branched isidia (about 0.07 mm in diameter). Isidia are not constricted near the base and, when

branched, near the base of branchlets in *X. piedmontensis*. Chemically *X. piedmontensis* resembles *X. subramigera*, because these two species produce succinprotocetraric acid as the major component and fumarprotocetraric acid as the minor product in the medulla. In contrast, in *X. tuberculiformis*, fumarprotocetraric acid, the major component, always accompanies a minor amount of protocetraric acid as in *X. hirosakiensis*. With respect to the chemistry, the difference between *X. tuberculiformis* and *X. piedmontensis* is quite similar to that observed between *X. hirosakiensis* and *X. subramigera*.

Distribution. The present new species is known from Japan, through Hokkaido in the north to Kyushu in the south. One specimen collected in East Nepal is identical with this species, even though no other specimen of this species has been collected in other areas of south-eastern Asia.

Specimens examined. Japan. Hokkaido. Prov. Kitami: Rishiri Island, elevation about 5 m, H. Kashiwadani 8203-b; Shanai-Sando, Esashi-gun, elevation about 100 m, H. Shibuichi 7477. Prov. Hidaka: Mt. Apoi, elevation about 600 m, S. Takahashi 15. Honshu. Prov. Mutsu: Same-machi, Hachinohe, F. Fujikawa 2002; Mt. Iwaki, elevation 1500–1600 m, H. Kashiwadani 34350; Okoppe, Shimokita-gun, Z. Nakajima 1638. Prov. Uzen: Mt. Iburisashi, Iide Mts., M. Togashi s.n. Prov. Kozuke: Mt. Nabewari, Mt. Akagi, S. Kurokawa 58587. Prov. Musashi: Shirasuna Park, Yoshida, Chichibu-gun, H. Shibuichi 44. Prov. Echigo: Mt. Jigami, Iide Mts., M. Togashi s.n. Prov. Shinano: Mt. Uchiyama-kyo Gorge, Saku City, elevation about 750 m, H. Kashiwadani 9604 & 9611; Tenguppara, Mt. Shirouma, Y. Asahina s.n. Prov. Mikawa: Mt. Horaiji, Minamishidara-gun, Y. Asahina s.n. Prov. Tajima: Kasumi Seashore, Kasumi-machi, Kinosaki-gun, Yoshihiro Ikoma s.n. Prov. Tamba: Nishihara Ayabe, M. Togashi s.n. Prov. Bingo: Mt. Hiba, Hiba-gun, elevation about 1200 m, H. Kashiwadani 8412. Prov. Aki: Mt. Hiba-yama, elevation about 1100 m, H. Kashiwadani 12532. Kyushu. Prov. Bungo: Mt. Monjusen, Kunisaki Peninsula, S. Kurokawa 62419; Mt. Daisen-zan, Kuju Mts., S. Kurokawa 62355; Mt. Yufu-dake, S. Kurokawa 62283. Prov. Higo: Haganoyu, Oguni-machi, Aso-gun, M. Togashi s.n. Nepal. East Nepal, M. Togashi s.n.

**Xanthoparmelia botryoides** Kurok., sp. nov. (Fig. 3)

Thallus ut in *Xanthoparmelia hirosakiensi*, sed superficie inferiore fusco-vel nigro-brunnescenti differt. Thallus acidum usnicum, acidum fumarprotocetraricum et acidum succinprotocetraricum continens.

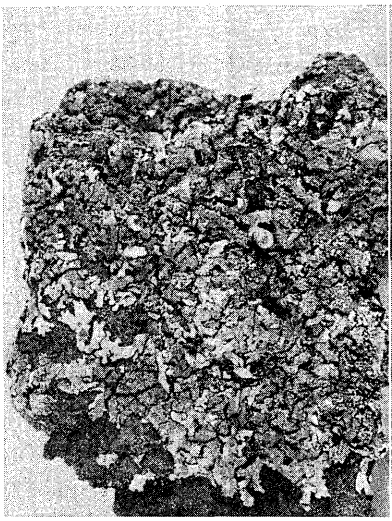

Fig. 3. Part of holotype of *Xanthoparmelia botryoides* Kurok. (×1.4).

Fig. 4. Part of holotype of *Xanthoparmelia claviculata* Kurok. (×1).

Thallus adnate, yellow-green, saxicolous; lobes subirregular to sublinear, often imbricate, 0.8–2 mm wide, upper surface more or less shiny, emaculate, often black margined, isidia simple and subglobose or branched and subcoralloid or even botryose, branchlets short, constricted near the base; medulla white; lower surface dark brown to blackish brown; rhizines simple, moderate, of the same colour as the lower surface or blackish. Thallus 150–190 μm thick; upper cortex about 12 μm thick; algal layer continuous, variable in thickness, 27–42 μm thick; medulla 85–110 μm thick; lower cortex brown to blackish brown in the outer half, about 12 μm thick. Apothecia rare, subsessile, 3–10 mm in diameter, disc more or less concave, chestnut brown, margin more or less undulate, sometimes deeply incised, amphithecium isidiate; hymenium about 50 μm high; spores colouless, simple, 5×10–11 μm.

Chemistry. Thallus K−; medulla K−, C−, KC−, P+ orange red; containing usnic acid, fumarprotocetraric acid and succinprotocetraric acid.

Type. Japan, Goto Islands, Sakiyama, Fukue City, Fukue Island, S. Kurokawa 82106-a—holotype in TNS.

This new species may be confused with *X. hirosakiensis* or *X. tuberculi-*

*formis*, which both are rather common in Japan. However, fumarprotocetraric and succinprotocetraric acids are demonstrated as medullary products in this species, whereas fumarprotocetraric acid accompanies a minor amount of protocetraric acid in the latter two species. Morphologically, the present new species much resembles *X. tuberculiformis*. In addition to the chemical difference mentioned above, *X. botryoides* has dark to blackish brown lower surface of lobes, while the lower surface is jet black in *X. tuberculiformis*.

*Xanthoparmelia botryoides* resembles *X. piedmontensis* (Hale) Hale, a North American isidiate species, which also produce usnic, fumarprotocetraric and succinprotocetraric acids. While succinprotocetraric acid is the major product in the medulla and usually accompanies a minor amount of fumarprotocetraric acid in *X. piedmontensis*, both substances seem to be produced in a similar amount in *X. botryoides*. Ratios of amount of fumarprotocetraric acid to that of succinprotocetraric acid vary 1:0.69 to 1:1.55 in *X. botryoides*. On the other hand, isidia are cylindrical and often coralloid-branched and are 0.3–0.8 mm in height and 0.08–0.1 mm in diameter in *X. piedmontensis*, whereas they are subglobose or subclavate and even botryose when branched, and are 0.2–0.5 mm in height and 0.1–0.15 mm in diameter in *X. botryoides*.

The holotype specimen is unfortunately sterile and the description of apothecia was taken from a specimen collected at Azusayama, Prov. Shinano (S. Kurokawa 58534).

Distribution. *Xanthoparmelia botryoides* seems to be an endemic species distributed at lowland in eastern and south-western Japan, including Shikoku and Kyushu. It is noteworthy that this species is very common on the Oki Islands, which are located in the Japan Sea about 80 km north of Shimane Peninsula.

Specimens examined. Japan. Prov. Musashi: Tochimoto, Chichibu-gun, elevation about 800 m, H. Shibuichi 4085 & 4086. Prov. Shinano: Azusayama, Kawakami-mura, Minamisaku-gun, elevation 1400–1500 m, S. Kurokawa 58534. Prov. Mino: Kirii, Shirakawa-machi, Kamo-gun, elevation about 500 m, S. Kurokawa 68010. Prov. Oki: Kuniga-kaigan, Nishinoshima Island, Oki Islands, S. Kurokawa 84017; Kuniga, Chibu-gun, elevation about 40 m, H. Kashiwadani 6143; Mt. Daimanji, Dohgo, Chibu-gun, H. Kashiwadani 5839 & 5855; Mt. Takuhi, Dozen, elevation about 50 m, H. Kashiwadani 6142; Nakamura, Fuse-mura, on rocks along the sea, H. Kashiwadani 21061 & 21067; en route from Utaki to

Nakasato, Tsuma-mura, elevation about 80 m, H. Kashiwadani 20969 & 20980. Prov. Inaba: Tottori, Ken Yasuda s.n. Prov. Aki: Mt. Mikura, Ohtake City, elevation about 600 m, H. Kashiwadani 1547; Haji, Yachio-cho, Takata-gun, elevation about 260 m, H. Kashiwadani 8718. Prov. Tosa: Tosa-Yamada, Kami-gun, S. Kurokawa 60191. Prov. Iyo: Panorama-dai, Omogo, elevation about 700 m, S. Kurokawa 60093. Prov. Bungo: Mt. Monjusen, Kunisaki Peninsula, S. Kurokawa 62420. Goto Islands; Sakiyama, Fukue City, Fukue Island, S. Kurokawa 82106-b.

**Xanthoparmelia claviculata** Kurok., sp. nov. (Fig. 4)

Species habitu cum *Xanthoparmelia scabrosa* optime congruens, sed differt isidiis subglobosis vel subclavatis praeterea subcoralloideo ramosis, apicibus non erumpentibus.

Thallus adnate to moderately adnate, yellow-green, saxicolous; lobes sublinear-elongate, sometimes imbricate, 0.8–2.0 mm wide; upper surface more or less shiny, emaculate, often black margined near lobe apices, with sparse to numerous isidia, isidia never opened at the apices, simple isidia subglobose to subclavate, up to 0.25 mm in height and 0.07–0.15 mm in diameter, branched isidia subcoralloid, often more than 0.4 mm in height and 0.12–0.15 mm in diameter, branchlets constricted near the base; medulla white; lower surface brown to dark brown; rhizines simple, rather sparse, of the same colour as the lower surface. Thallus 150–170 $\mu$m thick; upper cortex 10–12 $\mu$m thick; gonidial layer subcontinuous, 30–43 $\mu$m thick; medulla 85–120 $\mu$m thick; lower cortex pale brown in the outer half, about 17 $\mu$m thick. Apothecia not seen.

Chemistry. Thallus K−; medulla K−, C−, KC+ rose, P−; containing usnic acid, norlobaridone (major), loxodin (± trace), and two unknown substances (trace).

Type. Japan, Shikoku, Prov. Tosa, Ikume, Toyo-cho, Aki-gun, on escarpment along coast, S. Kurokawa 83042—holotype in TNS.

The present new species has been confused with *X. scabrosa* (Tayl.) Hale (Yoshimura 1974, Elix et al. 1986). In fact, these two species have similar thalli with pale lower surface and produce usnic acid and norlobaridone in common. However, isidia are subglobose or subclavate and often subcoralloid-branched and never opend at the apices in *X. claviculata*, while in *X. scabrosa* they are warty and subglobose at first and develop into short subcylindrical isidia, which become inflated at the apices and burst open. In addition, the

lower surface of lobes is usually pale brown in *X. scabrosa*, while it is brown to dark brown in *X. claviculata*. Usnic acid and norlobaridone usually accompany a minor amount of loxodin in *X. scabrosa*. In contrast, loxodin is rarely demonstrated only in trace amount in *X. claviculata*.

The presence of isidia, the brown lower surface of lobes and the production of usnic acid and norlobaridone are features which immediately call *X. amplexula* (Stirt.) Elix et Johnston, an Australian and New Zealand species, to mind. However, *X. claviculata* differs from *X. amplexula* in the shape and size of isidia: *X. amplexula* has slender, cylindrical isidia, which are mostly simple and about 0.3 mm in height and 0.05–0.07 mm in diameter.

Asahina (1952) referred the present species to *Parmelia loxodes*, which is now known as a species of different genus, *Neofuscelia loxodes* (Nyl.) Essl. (Esslinger 1978). *N. loxodes* is known from Eurasia and North America, but is not known from Asia (Esslinger 1977).

Distribution. This species is at present known from Japan and Taiwan. In Japan, the distribution range seems to be restricted to western Japan, where this species is usually saxicolous but also often grows on roof tiles of Japanese stile houses.

Specimens examined. Japan. Honshu. Prov. Suruga: Shizuoka, S. Kurokawa 72012. Prov. Owari: Vicinity of Inuyama, Y. Asahina s.n. Prov. Ohmi: on roof tile, Ayamehama, Lake Biwa, Yasu-gun, S. Kurokawa 64377, 64379, 64385 & 64386. Prov. Kii: Shiogama Shrine, Wakano-ura, Wakayama City, M. Togashi s.n. Prov. Suo: en route from Akamatsu to Shimizu, Hinode-cho, Hayami-gun, on roof tiles, elevation about 30 m, Y. Umezu 96. Shikoku. Prov. Awa: Sanagochi-mura, Myoto-gun, T. Inobe 198. Kyushu. Prov. Hizen: Honkoji Temple, Shimabara, Y. Asahina (no. 58907) & M. Togashi. Prov. Higo: Isshochi, Kuma-mura, Kuma-gun, S. Kurokawa 63137. Taiwan. En route from Keelung to Tamsui, S. Kurokawa 1279-b.

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revision of lichen genus *Xanthoparmelia*. Bull. Br. Mus. (Nat. Hist.), Bot., **15**: 163-362. Esslinger, T. L. 1977. A chemosystematic revision of the brown *Parmeliae*. Journ. Hattori Bot. Lab. **42**: 1-211. ——— 1978. A new status for the brown *Parmeliae*. Mycotaxon **7**: 45-54. Yoshimura, I. 1974. Lichen flora of Japan in colour. 349 pp., 48 plates. Hoikusha, Osaka.

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前報に引続き，日本産のキクバゴケ属の4種について検討した。

*X. hirosakiensis*（キクバゴケモドキ）は *X. subramigera* (Gyeln.) Hale と混同されてきたが，ウスニン酸のほかにフマールプロトセトラール酸と微量のプロトセトラール酸を含むので，スクシンプロトセトラール酸を主成分とし，フマールプロトセトラール酸を随伴成分とする *X. subramigera* とは別種である。また，地衣体裏面の色や，裂芽の形状にも相違が見られる。フマールプロトセトラール酸，スクシンプロトセトラール酸，プロトセトラール酸は生合成的にも近縁の物質であるが，主成分の置換と随伴成分の相違は，ここではそれぞれの種の特徴とみなすことができる。北海道および本州北部で最も普通に見られる種であり，中国東北部にも産する。

*X. tuberculiformis*（ニセキクバゴケ）も，北米産の *X. piedmontensis* (Hale) Hale と混同されてきたが，スクシンプロトセラール酸を主成分，フマールプロトセトラール酸を随伴成分とする *X. piedmontensis* に対して，フマールプロトセトラール酸を主成分，プロトセトラール酸を随伴成分とする点で明らかに異なる。また，裂芽の形も *X. piedmontensis* では，細い円筒状であるのに対して，*X. tuberculiformis* の裂芽は，最初やや球形であるが，後に枝分かれし，枝の基部がくびれているため，全体としては塊茎の集合体のように見える。日本では北海道から九州にかけて普通に見られる。国外ではネパールの1標本がある。

*X. botryoides*（トゲツブキクバゴケ 新称）は前記の *X. piedmontensis* に似ているが，地衣体裏面は真黒色ではなく，褐色ないし黒褐色である。裂芽の形にも特徴があって，枝分かれしたものは珊瑚状に伸びることはなく，枝が短かいためむしろ葡萄の房形の裂芽となる。化学的には *X. piedmontensis* に近いが，フマールプロトセトラール酸とスクシンプロセトラール酸がほぼ同量検出される点が異なる。日本特産。

*X. claviculata*（ノルロバリドンキクバゴケ）はオーストラリア，ニュージランドを中心として分布する *X. scabrosa* (Tayl.) Hale と同一種とみなされてきたが，裂芽は棍棒状あるいはさらに分枝してやや珊瑚状になるが，先端は崩壊してパスチュールになることは決してない。日本では西日本に主として分布し，台湾北部でも発見されている。